論　文

Equifinality and Multifinality in Children's Language Development:

A Case Study on Blind and Sighted Children

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要　旨

子どもの言語獲得の過程は一様ではなくむしろ多様である。例えば語彙や構文の獲得において子どもはそれぞれ異なる発達の道筋をたどったとしても，最終的には同じ言語の体系的獲得に到達する過程が観察される。これを発達の等至性という。本研究では，子どもの二言語使用の環境への適応として，等至性とは反対の，初期は同じ特性を持ちながらも発達の過程で多様性を示し異なる到達点に至る多径路性の発達事例に注目し，Karmiloff-Smith の表象書き換え理論の枠組みで検討した。先行研究から，日本語を母語とする晴眼児（定型発達）および弱視児と先天盲の子どもは，幼児期には共通してプロソディー情報に依存した言語処理方略を用いることが報告されている。しかし，児童期以降には，晴眼児および弱視児と，先天盲児ではそれぞれ異なる言語処理方略を発達させていくという多径路性が報告され，学習する文字特性（墨字か点字か）の影響が示唆されている。本研究では文字特性以外の影響を探るため，先行研究で対象とした幼児期から児童期中期までの晴眼児，弱視児，先天盲児の言語発達の変化を調査した。その結果，日英語バイリンガルの先天盲児は学齢期にモノリンガル児童とは異なる言語処理方略と語彙カテゴリーを独自に形成していることが見出された。本事例は，児童期に習得した点字の特性と，複数言語の獲得によってさらなる言語表象の書き換えが促進された結果として生じた多径路性であると考えられる。

キーワード：言語処理，表象書き換えモデル，バイリンガル児，
文字特性，発達の多径性

1. Introduction

This study investigates factors affecting both blind and sighted children's language development from early to middle childhood within the cognitive developmental framework developed by Karmiloff-Smith (1996).

Children's mastery of literacy motivates their representational redescriptions of the word category, which, in turn, determine a developmental change and differences in language processing between the blind and sighted. It is reported that compared to the sighted children, Japanese blind children show unique developmental tendencies in their language processing strategies in middle childhood after acquiring literacy (Sugimoto, 2017). The fundamental mechanism behind this developmental change is that the types of orthography learned by children, that is, the Braille alphabet alone or three types of Japanese characters corresponding to each of the Japanese word categories, determine the directions of their representational redescriptions. It also results in a qualitative difference in language processing strategies between the literate blind and sighted children. This can be seen as an example of visual deprivation leads to blind children's unique language development. Does orthographic knowledge alone influence children's language development?

We conducted experiments to investigate how both lexicon and literacy affect Japanese children's developmental discontinuity in language processing. We examined the effects of orthography and bilingual lexicon and attempted to explain their developmental pathways, i.e., multfinality, in the framework of representation redescriptions (Karmiloff-Smith, 1992).

1.1 Principles of Developmental Pathways (Feiring & Lewis, 1987)

Equifinality and multifinality are key principles for developmental research. Equifinality and multifinality both describe developmental trajectory or prior developmental pathways. Equifinality can be seen as a number of initial, different pathways that lead to the same outcome. On the other hand, multifinality refers to a process where a similar initial state (e.g., levels of a behavior) results in multiple

pathways that lead to different outcomes. Multifinality is explored in a longitudinal study of children assessed for attachment classifications. Similar initial conditions led to dissimilar outcomes.

1.2 The Representational Redescription Model of Children's Cognitive Development

Karmiloff-Smith (1992)'s RR model aims to explain how children's mental representations become more manipulable and flexible and accessible to their own mental state through development.

The RR model assumes four levels of representations (initial state, three external phases) and the model incorporates a reiterative process of representational redescription. Representational redescription is a domain-general process and not limited to linguistic knowledge. According to the RR model, development involves three recurrent phases. A child first attends to information from external environment (phase 1). "During phase 1, children focus on external data to create representational adjunctions" (Karmiloff-Smith, 1996: 18). Behavioral change entails but not identical to representational change in the RR model.

In phase 2, children's knowledge representations predominate information coming from the external environment. During this phase, children become accessible to internal data and less attentive to the information coming from their external environment. Their information processing become somewhat inflexible to control. During phase 3, children now reconcile their internal representations and external data so that they can access to external information with ease.

1.3 Rendaku Processing

This paper examines children's language development phases through their rendaku processing strategies. *Rendaku* (sequential voicing) is a morpho-phonological process in Japanese that voices the initial obstruent of the second element of a compound (Ito & Mester, 1995; Vance, 2015). This is exemplified in (1).

(1)	N1	+	N2	→	N3 (Compound Word)	
	umi	+	***kame***	→	*umi-**g**ame*	/k/ →[g]
	"sea"		"turtle(s)"		"sea turtle(s)"	

Rendaku does not apply to every word; it has constraints and irregularities concerning lexical strata and Lyman's Law. First, lexical strata are word categories stratified in the Japanese lexicon: *Yamato* (native vocabulary), Sino-Japanese (vocabulary of Chinese origin), foreign loan words, and onomatopoeia (Ito & Mester, 1995; McCawley, 1968). In principle, rendaku applies to words that belong to the native vocabulary (=*Yamato* morphemes). Second, *rendaku* is subject to Lyman's Law, which prohibits the occurrence of more than one voiced obstruents within a morpheme (Ito & Mester, 1995; Kubozono, 1999; Lyman, 1894; Vance, 2015). Lyman's Law is the language-specific instance of OCP (Odden, 2011; McCarthy, 1986) and is only applicable to native words (*Yamato*) in Japanese. It does not apply if words in E2 already contain a voiced obstruent.

(2) Examples of application of *rendaku* (only endocentric compounds are given)
a. yama+sakura → yamazakura (N2=*Yamato*)
b. umi+ hebi → umihebi (N2=*Yamato*, but rendaku prohibited by Lyman's Law)
c. niwaka+keiki → keiki (N2 = Sino-Japanese)
d. tʲiizu + keiki → tʲiizukeiki (N2=Foreign loan)

Rendaku also functions as a compound marker (Kageyama, 2010; Bauer, 2009: 345). It signals the beginning of the compound head. Rendaku does not apply to coordinate compounds (Lyman, 1894; Vance, 2015). Furthermore, rendaku has two types of irregularity (Rosen, 2003; Vance, 2015).

Neuropsychological studies have shown that *rendaku* has functions of signaling the syntactic, semantic, and morphological aspects of N2 within a compound (Ogata, Hayashi, Imaizumi, Hirata, & Mori, 2000). *Rendaku* has been mainly studied based on the data from adult speakers.

Some previous studies, either experimental or theoretical, assumed that the following two conditions are relevant to the adult grammar of *rendaku*, as given in (2) (Fukuda & Fukuda, 1999; Fukuda, 2002; Kubozono, 1999: 115–122; Ito & Mester, 2001: 55).

(3) The *Rendaku* Conditions (Sugimoto, 2017)
It applies if (a) N2 is a *Yamato* morpheme (native vocabulary); and
(b) N2 contains no voiced obstruent in it (Lyman's Law)

The above *rendaku* conditions seem complex and difficult for preliterate children to acquire since in order to be able to apply *rendaku* properly, they must know the lexical

strata and Lyman's Law. This means that children must be able to identify which word belongs to the native vocabulary. How do children learn the knowledge of category without having etymological or orthographic knowledge? In addition, how do children learn Lyman's Law and that it only applies to the native vocabulary?

The psychological reality of the Japanese lexicon, such as *Yamato* and Sino-Japanese words, has been empirically studied in Tamaoka and Taft (2009). They examined adult native Japanese speakers' mental representations of Japanese lexical strata by using *Kanji*[1] reading experiments. They have concluded that Japanese speakers' *Kanji* lexicon consists of sublexica, one for *On*-reading, and the other for *Kun*-reading, which respectively corresponds to *Yamato* and Sino-Japanese. They added that *Kanji* provides a base for constructing Japanese speakers' sublexica. Their findings suggest that there is a distinction or boundary between native words and Sino-Japanese words in the adult lexicon.

1.4 Children's Acquisition of Rendaku

Rendaku acquisition studies have assumed that children learn the adult's rendaku conditions (Fukuda & Fukuda, 1999; Fukuda, 2002). However, recent psycholinguistic studies have revealed that children do not acquire *rendaku* along with the adult's grammar. Instead, Japanese-speaking preschoolers develop a prosodically-based rendaku strategy (preschooler-specific *rendaku* strategy, Sugimoto, 2013b). The preschooler-specific *rendaku* strategy is also observed in English-Japanese simultaneous bilinguals. Sugimoto (2017) reported that preliterate blind children also show the preschooler-specific *rendaku* strategy.

(4) Preschooler-specific *Rendaku* Strategy based on the pitch accent (Sugimoto, 2013& 2017) Apply *rendaku* if N2 is an unaccented word.

Why do children attend to prosodic information instead of adult grammar of rendaku? Japanese is a language with a pitch accent system. Pitch accent is a prosodic feature of a word and it differentiates the meaning of each Japanese word. Pitch accent can be divided into two types: Accented and unaccented. Accented words have a tonal rise followed by a sudden fall. Unaccented words have no such a tonal (rise & fall) contour. Japanese-speaking adults and children do rely on pitch accent in their compound processing (Hirose & Mazuka, 2017).

Preschooler-specific *rendaku* processing reflects the distribution of pitch accent types of native vocabulary, to which *rendaku* applies. Descriptive studies show reports that approximately 71% of Yamato words (native vocabulary) are unaccented while more than 90% of loan words are accented with the pitch rise on their antepenult moras (Kubozono, 2006: 180). On the other hand, Sino-Japanese words cannot be characterized with respect to pitch accent: 49% of Sino-Japanese words have the antepenult accent while 51% are unaccented.

Children are aware that *rendaku* does not apply every word; it applies a particular category of words. They actively construct their own *Rendaku* rule, making best use of their knowledge: Apply *rendaku* if N2 is an unaccented native word. This preschooler-specific rendaku strategy can be interpreted as children's attention bias, which allows them to categorize Japanese lexicon based on the prosodic features alone. Children's attention bias enables them to learn language quite easily (Jusczyk, 1988; Karmiloff-Smith, 1992).

The sighted preschoolers' first learn the prosodically-based rendaku processing strategy: If N2 of a given compound is unaccented, then apply rendaku. A developmental change from preschooler-specific to adult-like rendaku processing in middle childhood. The correspondence between Japanese lexical strata and its orthography may direct children's redefinition of rendaku (Sugimoto, 2016b).

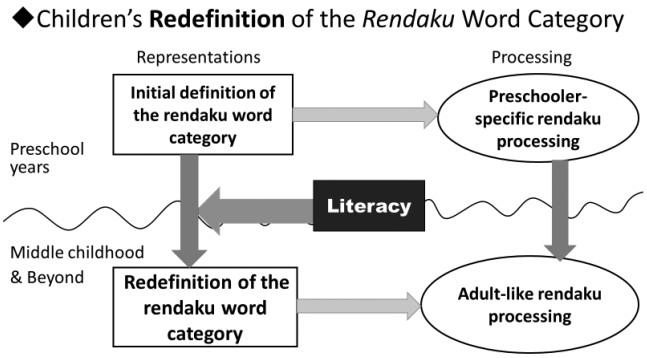

Figure 1　Children's Redefinition of the Rendaku Word Category for the sighted

1.4.1　Literacy and Representational Redescriptions in Blind Children

It is also reported that Japanese blind children show unique developmental tendencies in their language processing strategies in middle childhood after acquiring literacy

(Sugimoto, 2017). The fundamental mechanism behind this developmental change is that the types of orthography learned by children, that is, the Braille alphabet alone or three types of Japanese characters corresponding to each of the Japanese word categories, determine the directions of their representational redescriptions. This also results in a qualitative difference in language processing strategies between the literate blind and sighted children. Does orthographic knowledge alone influence children's language development? Children's mastery of literacy motivates their representational redescriptions of the word category, which, in turn, determine a developmental change and differences in language processing between the blind and sighted (Sugimoto, 2017). Preliterate preschoolers with, both the blind and the sighted, showed prosodically-based rendaku processing; after acquiring literacy they showed adult-like rendaku processing.

Blind children showed a developmental change in rendaku processing after acquiring literacy in Braille. Both literate blind children (with Braille alphabetic knowledge) and literate blind adults showed overgeneralizations of rendaku processing.

Literacy motivates children's redefinition of rendaku (a→b→c) Literacy development based on different orthographic systems (Kana or Braille) and different redefinitions of the rendaku word category emerge, which result in distinctive rendaku-processing strategies between the blind and the sighted.

1.4.2 Rendaku Processing and the Bilingual Lexicon: Effects of Two Language Systems

How does bilingualism affect the developing lexicons and language processing of children? The preschooler-specific *rendaku* strategy is also observed in English-Japanese simultaneous bilinguals (Sugimoto, 2016a). They show the preschooler-specific rendaku processing just like monolingual Japanese-speaking children do; they change to show the adult-like rendaku after acquiring literacy.

How does acquiring two languages affect the developing lexicons and language processing of children? This study investigates bilingual children's language development from early to middle childhood in comparison with that of monolingual children. Children's mastery of literacy motivates their representational redescriptions of the word category, which, in turn, determine a developmental change and differences in language processing between the blind and sighted. It is reported that Japanese blind

children show unique developmental tendencies in their language processing strategies in middle childhood after acquiring literacy (Sugimoto, 2017). The fundamental mechanism behind this developmental change is that the types of orthography learned by children, that is, the Braille alphabet alone or three types of Japanese characters corresponding to each of the Japanese word categories, determine the directions of their representational redescriptions. This also results in a qualitative difference in language processing strategies between the literate blind and sighted children. Does orthographic knowledge alone influence children's language development?

Through longitudinal experiments, we investigated how monolingual and bilingual blind children develop their lexicon and language-processing skills with respect to sighted and blind children. Our experiments used compound noun production tasks to investigate the developmental change in Japanese-specific rendaku processing and children's definitions of the Japanese word category in the lexicon. For blind children, we developed a set of experimental stimuli using raised pictures.

The study comprised 97 typically developing children (the sighted), 3 congenital blinds, and 3 children with severe visual disorder (low vision) as participants. They had measured their developmental changes for three years. They analyzed children's language production in compound noun formation and acoustically compared the language-specific rendaku processing patterns of monolingual/bilingual and sighted/blind children before and after acquiring literacy (Japanese *kana* characters for the sighted and Braille for the blind). Their results demonstrated that unlike monolingual blind children, the English-Japanese bilingual blind showed no overapplication of rendaku processing to foreign loanwords but its overapplication to Sino-Japanese words (vocabulary of Chinese origin). These results suggest that acquiring proficiency in more than one language enables blind children to restructure the lexicon and create a new lexical boundary, which is not likely for monolingual blind children.

(5) The results from previous studies summarized (Sugimoto, 2017)
   1. Preliterate preschoolers with, both the blind and the sighted, showed prosodically-based rendaku processing; after acquiring literacy they showed adult-like rendaku processing.
   2. Blind children showed a developmental change in rendaku processing after acquiring literacy in Braille.

3. Both literate blind children (with Braille alphabetic knowledge) and literate blind adults showed overgeneralizations of rendaku processing.

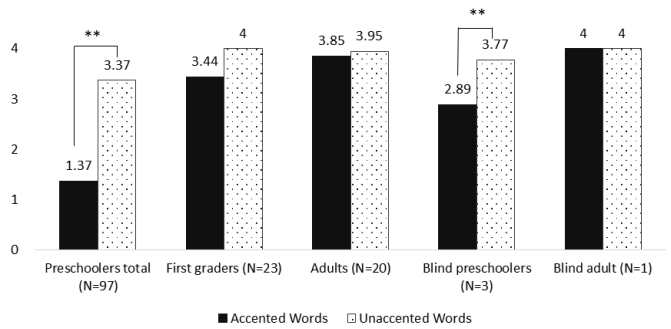

Figure 2 Rendaku processing patterns (reproduced based on the data from Sugimoto, 2017)

Both blind and sighted children attend to prosodic information of language since it is the only accessible source of information. Then as they grow up, children develop their own literacy based on different orthographic systems (Kana & Chinese characters or Braille alone). Children's internal knowledge may differ, depending on the orthographic system they learn. Different types of internal knowledge motivates different redefinitions of the rendaku word category. For the blind children, who have learned Braille alphabet, the lexical distinction such as Yamato, SJ or loan words made by the Kana orthography is not accessible. This may result in distinctive rendaku-processing strategies between the blind and the sighted.

1.5 Research Aims

Through longitudinal experiments, we investigated how monolingual and bilingual blind children develop their lexicon and language-processing skills with respect to sighted and blind children.

Does literacy alone affect the redefinition of the rendaku category? Can children's acquisition of two languages affect their definition of it? How does the bilingual lexicon affect blind children's language development? If the bilingual lexicon directly influence either children's representation or processing, then monolinguals and bilinguals will have different definitions of the rendaku word category. If acquiring more than one language motivates representational redescriptions and determines rendaku processing, then bilingual children should show the similar overgeneralization of rendaku processing

like monolinguals do.

2. Methods

Our experiments used compound noun production tasks (Nicoladis, 2003; Sugimoto, 2016a&b) to investigate the developmental change in Japanese-specific rendaku processing (Vance, 2016) and children's definitions of the Japanese word category in the lexicon. The experiment was cross-sectional and had 3(lexical strata)*4(group). Children with typical development show preschooler-specific rendaku processing in the early childhood but their strategy changes after the middle childhood.

Our experiments used compound noun production tasks (Sugimoto, 2016a) with new linguistic stimuli added. Our participants comprised 3 congenital blinds (M= 62mo.; SD: 6.01; range: 57–71mo.) and 2 children with low vision (M: 72.5 mo.; SD: 1.5; range: 71–74 mo.), and 12 typically developing six-year olds: M=79.3 mo., SD=2.23).

As for the stimuli of the compound noun formation task, we used three types of lexical strata for N2: Yamato (e.g., 'kuruma' (=car)', 'sakura' (=cherry blossom), etc.), Sino-Japanese (e.g., 'hikouki' (=airplane), 'kyouryuu'(=diansaur), etc.) and English loans ('piano', 'tiishatsu' (=t-shirt), etc.). We used 'himawari (=sunflower)' for N1 throughout the trials (Sugimoto, 2016a).

Children were tested individually in a quiet room. We went through three trials: 4 warm-up trials, 4 comprehension trials, and finally the 20 test trials (N1=*hima'wari*). Typically-developing children were shown three types of pictures on a PC in a random order and were asked to name the third pictures (compound nouns). For blind children, we used sets of experimental stimuli using raised pictures (stickers). We used a SONY IC recorder (ICD SX-1000) and recorded the children's utterances in the experiment. Two people, one of whom was the author, listened separately to the recordings and transcribed them, judging whether or not the children voiced the target consonant (κ =.97).

3. Results and Discussion

We analyzed children's language production in compound noun formation and compared the language-specific rendaku processing patterns of monolingual/bilingual and sighted/blind children before and after acquiring literacy (Japanese *kana* characters

for the sighted and Braille for the blind).

Since all typically developing children and adults in the control group applied all and only rendaku to the target compounds, we now focus on the blind children and the children with low vision.

Our results demonstrated that after acquiring literacy, all the blind children showed overapplications of rendaku to non-native words. However, only the English-Japanese bilingual blind child showed a distinctive rendaku-processing strategy from early childhood through middle childhood. That is, unlike monolingual blind children, the bilingual blind showed a minimal overapplication of rendaku to English loanwords but its overapplication to Sino-Japanese words (vocabulary of Chinese origin; Figure 2). His overapplication of rendaku to Sino-Japanese words was not significantly different from monolingual blinds (z=.02). However, his overapplication of rendaku to English loan words was minimal and different from other monolingual blinds (z=2.02). These results suggest that acquiring proficiency in more than one language enables blind children to restructure the lexicon and create a new lexical boundary, which is not likely for monolingual blind children.

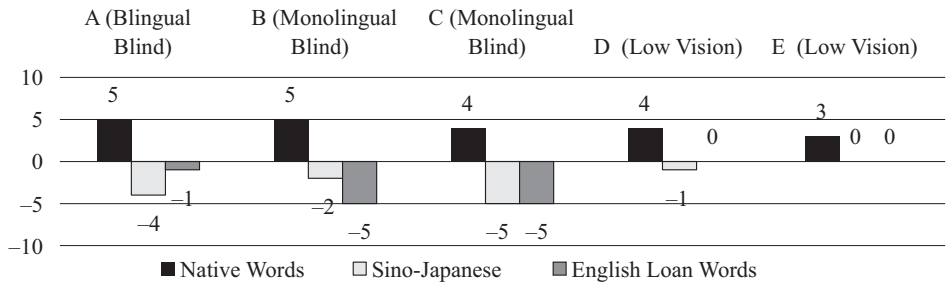

Figure 3 Overgeneralizations of Rendaku to Non-native Words by Blind Children (5pts. Max)

(The negative values in the Sino-Japanese and English loan word conditions indicate overgeneralizations of rendaku)

Our results demonstrated that unlike monolingual blind children, the English-Japanese bilingual blind showed no overapplication of rendaku processing to foreign loanwords but its overapplication to Sino-Japanese words. These results suggest that acquiring proficiency in more than one language enables blind children to restructure the lexicon and create a new lexical boundary, which is not likely for monolingual blind

children.

All blind children overgeneralized the rendaku rule to nonnative Sino-Japanese vocabulary. But the bilingual blind child did not overgeneralize it to the words of English origin. We can conclude that the bilingual blind obtained the lexical distinction between loan words which allowed him to distinguish the loan words of English origin from other loan words. By the time of the experiment, his bilingual lexicon had become unique and different from monolingual blinds or sighted bilinguals (Figure 3).

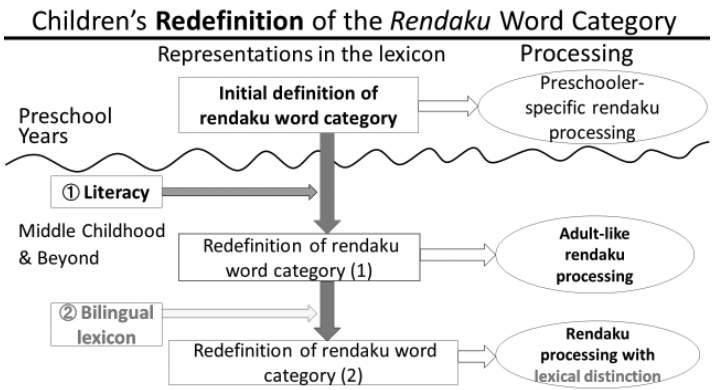

Figure 4　Bilingual lexicon and its effects on RR and processing

4. Conclusion

In conclusion, we have seen that the RRs model accounts for the example of multifinality of language development introduced in this paper. Unlike monolingual blind children, the English-Japanese bilingual did not overapply English words differently; but he overapplied rendaku to Sino-Japanese words just like monolingual blinds. The child's acquisition of bilingual lexicon motivated the child's representational redescription, which in turn affected his language processing of rendaku. This supports the basic principle of the RR model that children's representational redescription takes place through the acquisition of cognitive skills and knowledge through new learning. Children can flexibly change their representation in their original way in accordance with their linguistic environment. Both orthographic features and languages children learn determine their rendaku processing strategies, which result in multifinality observed in children's language development.

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Note

1 *Kanji* is one of the three types of Japanese orthography. It is a set of Chinese characters with basically two distinctive ways of reading: *On*-reading and *Kun*-reading.

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